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GUIDELINES FOR GREEN RATING OF HIGHWAYS

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GUIDELINES FOR GREEN RATING OF HIGHWAYS

INTRODUCTION

Road infrastructure serves as a lifeline for the economic growth and human development of a nation. Construction and Operation phases of roads however have environmental implications in terms of increased use of natural resources, energy consumption, greenhouse gas emission, air pollution, noise pollution, soil erosion, loss of ground water recharge points etc. The importance of providing environment protection measures and managing them has been highlighted in IRC:SP:108-2015 "Guidelines on Preparation and Implementation of Environment Management Plan". In addition, the road sector is also following various other IRC guidelines on greener technologies viz. Warm Mix technology, Cold Mix technology, Crumb Rubber Modified Bitumen (CRMB), Polymer Modified Bitumen (PMB), Recycled Asphalt Pavement (RAP), Use of Construction & Demolition wastes etc. Though Indian road sector is gradually moving towards increased use of greener technologies, a comprehensive quantitative and analytical approach for evaluating the degree of greener intervention is lacking. The present guideline provides a scientific methodology for evaluating the greener interventions of a project through adoption of "Green Rating System" for roads.

The concept of green encompasses the mechanism of conserving, enhancing and managing the quality and quantity of natural resources. Getting green in other words is getting conducive to nature. Green highway is the one which is designed, constructed and maintained with the ultimate aim of conserving, enhancing and managing the quality and quantity of natural resources. The degree of greener interventions, however, may differ from country to country as technologies required depend highly on their economic feasibility, technical knowhow and availability of means to make use of a technology.

Even within a nation, the degree may differ based on site specific conditions for projects in different climatic and bio-geographic regions. In such a condition, these guidelines will help in identifying if a road can be termed green/greener in terms of its interventions. This will also enable informed decision making. IRC felt that there is a need to formulate the guidelines for green rating of highways. Accordingly, task was assigned to Committee on Reduction of Carbon Footprint in Road Construction and Environment (G-3) of IRC.

The draft was discussed by G-3 Committee in a number of meetings. This document has been prepared after studying various International Green rating systems for highways and finalized after a rigorous and critical review by the members of G-3 Committee.

The G-3 Committee (list of personnel given below) in its meeting held on 05.10.2018 finalized the Guidelines and recommended its submission to General Specifications and Standards Committee (GSS) for its consideration.

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The GSS Committee in its meeting held on 24th October, 2018 after due deliberations on the document recommended its submission to the Council for its approval. The Council in its 216th meeting held at Nagpur (Maharashtra) approved the guidelines for printing.

1. GREEN RATING OF HIGHWAYS

Green rating for highways refers to rating of various components of highways in terms of their environment friendliness. This rating system is being introduced to encourage a quantitative assessment of environmental sustainability of highways.

1.1 Need For Green Rating

India has voluntarily committed in Conference of Parties (COP 21) to reduce the carbon emission intensity of its GDP by 33 to 35 per cent by 2030 from 2005 Level. Road transportation is one amongst the major carbon emission contributing sectors. India has more than 2.5 lakhs km of National and State Highways network spread all over the country that leaves behind its environmental footprint (including carbon footprint) during construction, maintenance and operation. Presently, there is no such system that can quantify the environmental footprint of upcoming and ongoing road projects. These guidelines will help produce a rating for the reduction in environmental footprint of highway projects and hence enable the road authorities towards assessing the contribution of the main highways in achieving the commitment of COP 21.

1.2 Comparative Analysis of Existing Green Rating Systems

The idea of green rating of highways evolved from LEED (Leadership in Energy and Environmental Design) standard for green buildings. LEED was introduced in 1998 by the U.S. Green Building Council (USGBC). Greenroads, specifically for road was established in 2010 that acted as a precursor to various other rating systems. This has also been dealt with in a study undertaken by Nature First for National Highways Authority of India on Green Guidelines and Green rating system for Indian highways.

A summary of some of the few existing green rating systems is given in **Table 1**.

Table 1 Comparative Analysis of Existing Green Rating Systems

Rating System	Attributes	Criteria
Green LITES (Leadership in Transportation Environmental Sustainability)	• Developed by the New York State Department of Transportation after the LEED system model. • Self-evaluation tools with non-recognized awards. • Follows 'triple bottom line' principle of Economy, Society and Environment. • Primarily for the internal use at NYSDOT. • Two types of certification program- Project Design and Operation. • Minimum point required for certification is 33%. • No mandatory requirements. • Less importance given for pavement technology and construction activities including quality control.	Project Design-20 criteria under 5 heads further sub divided into many sub criteria. The five heads are sustainable sites, materials and resources, water quality, energy and atmosphere and innovation. Operation- 16 categories further subdivided into many. Categories viz. bridge, pavement, drainage, signal and lighting, snow and ice, facilities, intelligent transport system, roadside environment, guide rails and fencing, marking, signs, fleet administration, walls and rock slopes, communication technology and emergency preparedness etc.

Rating System	Attributes	Criteria
Green roads [1,2]	• Developed by the University of Washington and CH2M HILL. • A rating system with third party recognition and awards. • Based on performance matrix used to score points. • Follows 'triple bottom line' principle of Economy, Society and Environment. • Minimum point required for certification is 27%. • No provisions to select the relevant criteria based on the type of project. • Can be applied for roadway design and construction.	11 Project Requirement (PR) criteria to qualify for getting rated viz. environmental review process, life cycle cost analysis, life cycle Inventory, quality control plan, noise mitigation plan, waste management plan, pollution prevention plan, low impact development, pavement management system, site maintenance plan and educational outreach. 6 main and 37 Voluntary Credits (VC) used to score points. 6 main credits are Environment and Water, Access and Equity, Construction Activities, Materials and Resources, Pavement Technologies and Custom Credits. Final credit is PR+VC.
Envision	• Developed by Institute of Sustainable Infrastructure, USA. • Self-assessment without awards. • Subjective scoring based upon levels of achievement for each criteria. • Includes design, construction, and maintenance elements. • Follows 'triple bottom line' principle of Economy, Society and Environment.	60 sub-criteria under 5 sections- Quality of Life, Leadership, Resource Allocation, Natural World, and Climate.
STEED (Sustainable Transportation Engineering & Environmental Design)	• Developed by H.W LochnerInc.,USA. • Self-evaluation tool without awards. • Voluntary in nature. • Follows 'triple bottom line' principle of Economy, Society and Environment. • Does not provide certification levels.	21 sub-categories under Environmental Quality, Social Quality and Economic Viability.

Rating System	Attributes	Criteria
	• Identify and incorporate sustainable options at four different stages- planning, environmental, design and construction. • Less importance given to pavement technology. • Criteria are based on broader perspective and do not look into finer details.	
I-LAST (Illinois – Livable And Sustainable Transportation Rating System)	• Developed by the Sustainability Group of the Illinois Department of Transportation (IDOT),USA. • Self-evaluation tool without awards. • Voluntary in nature. • Based on point system. • Scoring process has 3 steps. 1) Determining the items applicable to a project; 2) Evaluating the total points for the achieved items; and 3) Scoring by calculating the percentage of achieved points to the total available points. • Applicable sustainable practices would vary from project to project. Flexible in criteria selection. • Does not provide certification levels.	More than 150 sustainability criteria divided into 9 categories- planning, design, environmental, water quality, transportation, lighting, materials, construction and innovation.
IN-VEST (Infrastructure Voluntary Evaluation Sustainability Tool)	• Developed by the Federal Highway Administration, U.S Department of Transportation. • Web based self-evaluation tool with non-recognized awards. • Voluntary in nature. • Measurement method similar to LEED [3]. • Prepared referring Green Roads and Green LITES. • Follows 'triple bottom line' principle of Economy, Society and Environment. • Minimum point required for certification is 30%.	68 criteria based on sustainability best practices.

Rating System	Attributes	Criteria
	• Can be applied for planning, operation and maintenance stages. • No mandatory requirements. • No room for innovation or unlisted items.	
LEED (Leadership in Energy and Environmental Design)	• Developed by US Green Building Council for rating of green buildings. • Third party certification with award. • Voluntary in nature. • Deals on building design, construction, operation, interior design. • Adopts checklist approach. • Mandatory pre-requisite credits required to achieve certification at any level. • Points are allocated to credits according to their relative social, environmental and economic impacts in accordance with their weighting methodology. • Minimum point required for certification is 40%.	Criteria under 9 broad categories – Integrative Process, Location and Transportation, Sustainable Site, Water Efficiency, Energy and Atmosphere, Materials and Resources, Indoor Environmental Quality, Innovation in Design and Regional Parity.
BE²ST (Building Environmentally and Economically Sustainable Transportation Infrastructure-Highways) [4]	• Developed by Recycled Material Resource Center and University of Wisconsin-Madison, USA. • Emphasis on recycling , material use and construction. • Life cycle analysis techniques to provide quantitative assessment of the impacts associated with a highway construction project. • Based on quantitative metrics with predefined targets for each criterion. The targets were set based on various literature findings and practical arbitrary numbers. • Rates or scores for each criteria are determined by dividing the actual quantity achieved by the target viz. total recycled material content is equal to actual volume of recycled material in the project divided by target volume of recycled content.	Two criteria –Mandatory screening and Judgment; 10 sub-criteria- Social requirements including regulation and local ordinances, GHG emission, energy use, waste reduction, recycling, water consumption, hazardous waste, lifecycle cost, traffic noise, social carbon cost saving (The social cost of carbon is the cost to recover damages caused by CO_2 release to the atmosphere and can be used by an agency to account for the social benefits).

These rating systems (GreenLITES, Greenroads, Envision, STEED, I-LAST, and IN-VEST) have a common short coming as the LEED system for buildings i.e these credit based systems lack objectiveness in the criteria selection and weighting process. The rating procedures in these rating systems are not based on standardized metrics and hence the effect of meeting environmental targets in these rating systems cannot be quantified [4]. In addition some of these systems have defined too many criteria those could have been clubbed into smaller numbers. BE^{2}ST is the only one that uses a quantitative approach with predefined targets for each criterion.

Only Greenroads amongst all the above highway ratings system is award based. The main advantage of adopting an award-based rating system is that it can be used to demonstrate the sustainable initiatives of an agency to the general public [5].

Presently there are no universal standards set to assess the green aspects of a road based on a common platform applicable to site specific condition. The use of standards/targets would however assure reproduction of identical practices with similar results, so that classifications can be made with as little bias as possible. On the other hand, it is also realized that applying an umbrella credit system to all highway projects may prove counterproductive [6].

Hence, highway projects shall be evaluated based on their own project specific conditions. This green rating guidelines for highways have been developed with an attempt to overcome the major limitations of the present rating systems, considering existing environmental legislations in India and overall Indian perspective.

Green rating takes account of environment friendly, innovative techniques, recycling of materials, use of renewable resources etc. that have just started to come into practice in the Country. The system has 13 mandatory Qualifying Criteria (QC) and 7 Evaluating Criteria (EC) with 24 sub-criteria. Mandatory qualifying criteria are the bare minimum requirements for rating a project. While Evaluation Criteria are based on various parameters related to environment that needs to be quantified for all the alternatives of a particular project.

1.3 Objective

The objective of these guidelines is to provide a standard procedure for green rating of highways.

2. PRINCIPLES OF GREEN RATING SYSTEM IN INDIA

The defining principles are:

- Quantitative assessment of Evaluating Criteria (EC) [7].
- Comparison of quantitative value achieved with that of the existing or maximum feasible value of the same project road for a particular criteria. Comparisons with standards or targets are not possible as there is no existing legislation on greener roads in the country [7].
- Common unit of percentage has been used to provide a common and easy base for rating [7].
- EC are fixed but there is provision for adding criteria based on project specific conditions.

- Weightages are assigned to an EC based on the intensity of impact. As such, it may vary on project basis. Yet an order of weightages for the criteria and sub-criteria has been defined and is supposed to be followed. Alteration can be done based on suitable and scientific procedure.

3. PROCEDURE FOR GREEN RATING

An eight step procedure may be adopted for green rating of a highway project as described below:

Step-1 Identify the criteria to qualify for being assessed as a green or greener highway. A comprehensive list of qualifying criteria is given in **Table 2**. A project must have these components for being qualified to be assessed for green rating [7].

Step-2 List the criteria of evaluation and describe each in a project specific context. A standard list of evaluating criteria is given in **Table 3**. No exclusion of criterion is allowed. Inclusion is allowed based on site specific condition. Weightages have been assigned to each criteria and sub-criteria in the pattern given in 3rd column of **Table 3**. Weightage for criteria increases from W_1 to W_n in such a way that $W_1+W_2+W_3+\ldots..W_n=100$ or 1. Under each criterion the sub criteria shall also be weighted increasing from W_{1-1} to W_{1-n} in such a way that $W_{1-1}+W_{1-2}+W_{1-3}+\ldots..W_{1-n} = W_1$[7]. Since weightage assigned to a particular criterion depends on the severity of impact on that particular component for a specific project and its overall importance, weightage sequence can be changed based on Delphi technique or any other suitable and scientific procedure. Delphi technique will require checklist in **Annexure I** to be circulated to pre-identified experts of the consultant/concessionaire conducting green rating. Once individual experts fill up the checklist, a summary and analysis shall be made by the Team Leader. Delphi method is used to normalize the outcome and may be repeated till a consensus is not reached.

BOX 1: RAND developed the Delphi method in the 1950s, originally to forecast the impact of technology on warfare. The method entails a group of experts who anonymously reply to questionnaires and subsequently receive feedback in the form of a statistical representation of the "group response," after which the process repeats itself. The goal is to reduce the range of responses and arrive at something closer to expert consensus. The Delphi Method has been widely adopted and is still in use today (www.rand.org) [8].

A group's response might get influenced by a dominant individual, 'noise' (i.e irrelevant or redundant material) that obscures the directly relevant material offered by participants and group pressure that puts a premium on compromise. To avoid these undesirable aspects of group interaction the procedure of Delphi has three distinctive characteristics:

- **Anonymity-** Anonymity is a device to reduce the effect of the socially dominant individual. This can be obtained by eliciting separate and private answers to prepared questions. Answers or preferences of the group can be sought by the team leader through e-mails.
- **Controlled Feedback -** Controlled feedback is a device to reduce noise. A Delphi exercise will usually consist of several iterations where the results of the previous iteration are fed back to the respondents normally in a summarized form.

- **Statistical group response-** Any form of statistical index may be used to represent the group response.

A typical exercise is initiated by a questionnaire that requests estimates of a set of numerical quantities (e.g. Weightages to various criteria). The results of the first round will be summarized e.g. as the median and inter-quartile range of the responses and fed back with a request to revise the first estimate where appropriate. On second round those individuals whose answers deviate markedly from the median (e.g. outside the inter-quartile range of response) are requested to justify their estimates. These justifications are summarized, fed back and counter arguments elicited. The counter arguments are in turn fed back and additional reappraisals collected. This exercise is repeated until a consensus in opinion is reached. The procedure has been exercised and proven useful with material where there is no immediate way to evaluate the results [9].

Step-3 Creation of various scenarios of a project based on proposed conventional or greener interventions when a particular project is to be rated [7]. For existing road improvement or up-gradation scenarios will be:

Scenario-1: Quantification of criteria based on existing road or based on conventional approach or maximum feasible greener intervention.

Scenario-2: Quantification of criteria based on proposed greener intervention.

In case of a green field highway the scenario will be:

Scenario-1 Quantification of criteria based on maximum feasible greener intervention or based on conventional approach.

Scenario-2 Quantification of criteria based on proposed greener intervention.

Interventions on each criterion shall be represented in the form of percentage share of improvement upon existing condition or total improvement possible. For example scarified bitumen is being used in 20 km out of 60 km length of the road. So the percentage will be 33%. Approach and available guidelines to be followed while quantifying the EC are mentioned in **Table 4**.

In case of existing road

$$\text{Ranks (\%)} = \frac{\text{Achieved value for a parameter}}{\text{Existing value of the road/conventional practice/ maximum greener intervention}} \times 100$$

In case of Greenfield road

$$\text{Ranks (\%)} = \frac{\text{Achieved value for a parameter}}{\text{Value achieved following conventional practice/ maximum greener intervention}} \times 100$$

Step-4 Assign ranks to various criteria based on percentage. Standard list of ranks against percentage are as given in **Table 5**. Percentage from 0 to 100 has been assigned ranks from 0 to 7. As percentage share of improvement increases, rank also increases. Ranks shall be assigned parameter wise [7].

Step-5 Calculate total weighted rank by multiplying the weight of a criterion to its rank and then summed up to obtain total weighted rank achieved by the particular scenario using **formula 1** [7].

$$\text{Total weighted rank of one scenario } (TWRS) = \sum_{i=1}^{n} r_i * w_i \quad \ldots (1)$$

Step-6 Calculate maximum total weighted ranking for the project by assigning the highest value rank to each criterion and multiplying them by corresponding weightages assigned to them and then summing them up using f**ormula 2** [7]**.**

$$\text{Maximum weighted rank of project (MWRP)} = \sum_{i=1}^{n} r_h * w_i \quad \ldots (2)$$

Where, r_h is the highest rank i.e. 7

Step-7 Derive percentage share of weighted rank achieved by a particular scenario (as calculated in Step-5) out of the maximum weighted rank of the project (as calculated in Step-6) using **formula 3** [7].

$$\% \text{ of weighted rank} = \frac{\text{TWRS}}{MWRP} * 100 \quad \ldots . (3)$$

Step-8 Rate a particular scenario as Certified, Silver, Gold or Evergreen based on the percentage calculated in Step-7, as given in **Table 6** [7].

A flowchart on summary of green rating system procedure is given in **Fig. 1** below. An example of carrying out green rating of highways is given in **Annexure II**.

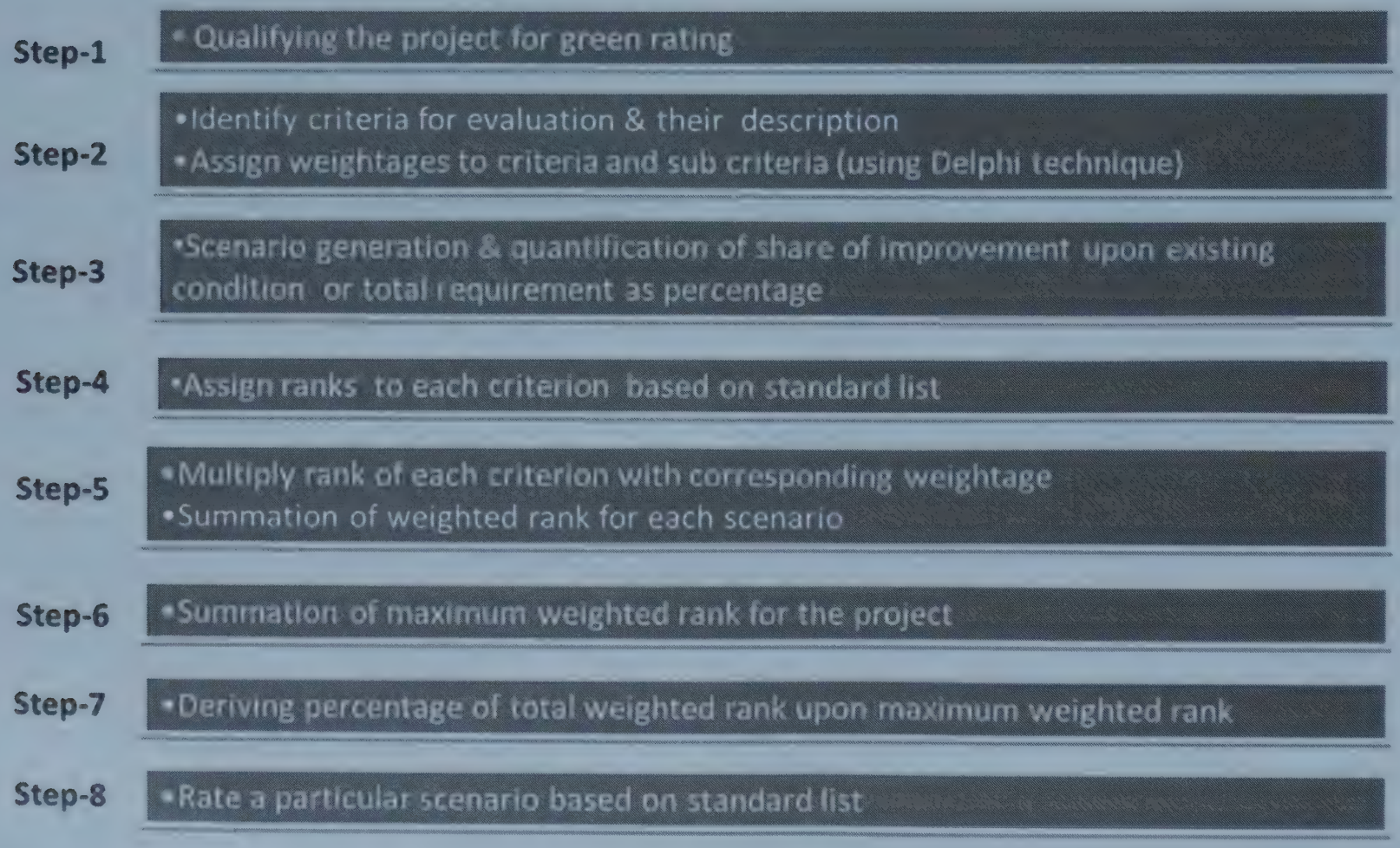

Step-1
• Qualifying the project for green rating
Step-2
•Identify criteria for evaluation & their description
•Assign weightages to criteria and sub criteria (using Delphi technique)
Step-3
•Scenario generation & quantification of share of improvement upon existing condition or total requirement as percentage
Step-4
•Assign ranks to each criterion based on standard list
Step-5
•Multiply rank of each criterion with corresponding weightage
•Summation of weighted rank for each scenario
Step-6
•Summation of maximum weighted rank for the project
Step-7
•Deriving percentage of total weighted rank upon maximum weighted rank
Step-8
•Rate a particular scenario based on standard list

Fig. 1 Summarized flowchart of Green Rating System

Table 2 Mandatory Qualifying Criteria (QC) for Roads to be considered for Green Rating

S. No	Qualifying Criteria	Incorporated in EIA or Design report (Yes/No)	Reference to the section of EIA or Design report
1.	Extensive study with baseline of all environmental parameters and Strength Weakness, Opportunity Threat (SWOT) analysis of identified issues		
2.	Storm water management measures		
3.	Noise attenuation measures		
4.	Liquid and solid waste management measures (solid waste includes all types of waste likely to be generated)		
5.	Air pollution mitigation measures		
6.	Life cycle cost analysis of pavement material		
7.	Greenhouse gas emission assessment for construction, maintenance and operation period		
8.	Life cycle inventory of pavement material		
9.	Stakeholders consultation plan		
10.	Formal Contractor quality control plan		
11.	Environment Monitoring plan for pre-construction, construction and operation stage		
12.	Plantation plan		
13.	Environmental Management Plan for pre-construction, construction and operation stage as per IRC:SP:108-2015 and subsequent amendment, if any.		

Table 3 Standard list of Evaluating Criteria (EC) and Weightages for Highways

S. No	Criteria and Sub-criteria	Weightages	Description
1.	**Sustainable Design (SD)**	**W5**	
SD-1	Alignment design	W5-3	The design of road alignment is existing/ new; any innovative measure taken to curb the main identified issues of road users or road side dwellers. Incorporation of users' and local stakeholder's views and requirement into the design (no. of interventions recommended out of the requirements expressed by users).

S. No	Criteria and Sub-criteria	Weightages	Description
SD-2	Traffic flow improvement	W5-1	Reduction in congestion or average speed expected after improvement; use of weigh-in-motion technology to avoid congestion; Use of Intelligent Transportation system (ITS) for better traffic management.
SD-3	Traffic safety	W5-2	Reduction in human-vehicle conflict; vehicle-vehicle conflict; cattle vehicle conflict; provisions for differently abled people; use of weigh-in-motion technology to reduce overloading of vehicles and thus ensure safety; use of ITS to ensure safety.
SD-4	Long life pavement design	W5-6	Life cycle (years); frequency of mandatory maintenance; Climate resilient design.
SD-5	Habitat fragmentation	W5-5	Fragmentation of human or animal habitat and provisions for crossing.
SD-6	Cut & Fill	W5-4	Kind of topography through which the alignment is passing; amount of earthwork required.
2.	**Materials & Resources (MR)**	W7	
MR-1	Recycled content	W7-1	Use of construction and demolition debris. Use of scarified bitumen in construction as sub-base. Use of recycled material or industrial by products/reduction in waste dumps.
MR-2	Carbon footprint	W7-2	Reduction in carbon emission during construction (both embodied emission of materials and direct emission due to fossil fuel burning).
3.	**Storm Water Management (SM)**	**W4**	
SM-1	Provision for management practice	W4-5	Type of technology used and extent covered; Use of Integrated storm water management system i.e. Integration with landscaping and ground water recharge and pre-separation from sewage.

S. No	Criteria and Sub-criteria	Weightages	Description
SM-2	Maintenance	W4-1	In terms of maintenance requirement and estimated life of the structure in comparison with a traditional storm water drain.
SM-3	Run off treatment	W4-2	Amount of run off to be treated and pollutants that could be removed.
SM-4	Ground water recharge	W4-4	Amount of water that could be recharged.
SM-5	Permeable area	W4-3	Share of permeable area to that of non-permeable.
4.	**Energy and Environment (EE)**	**W6**	
EE-1	Cool pavement	W6-5	Pavement with higher albedo.
EE-2	Lighting efficiency	W6-3	Use of renewable energy sources with low electricity consuming fixtures.
EE-3	Noise Attenuation	W6-4	Reduction in noise level using on road and off road treatments.
EE-4	Carbon sequestration/ reduction in emission	W6-8	Carbon footprint sequestration due to soil and plantation. Reduction in vehicular carbon emission due to maintenance of desired pavement roughness and road configuration.
EE-5	Vehicular emission of ambient air pollutant	W6-6	Improvement in ambient air quality during operation.
EE-6	Site Vegetation or Plantation Plan	W6-7	Share of vegetation cover within the project area.
EE-7	Solid and liquid waste management	W6-2	Share of solid and liquid waste treatment both during construction (in camps) and operation (in way side amenities and toll plazas) using bio-toilets, packaged sewage treatment plant, organic waste convertors, recycling of inorganic waste, oil interceptors etc.
EE-8	Environment, Health and Safety	W6-1	Share of provisions covered for hygienic, safe and healthy environment in the EHS plan with reference to Circular Memo No: SAC/CT & PT/2015 dated 13-08-2015 of Swachha Andhra Corporation, MA&UD Department and World Bank's General EHS Guidelines (www.ifc.org/ehsguidelines).

S. No	Criteria and Sub-criteria	Weightages	Description
5.	**Interventions as Reparation Activities (RA)**	**W3**	
RA-1	Rain water harvesting through ponds	W3-2	Enhancement of ponds through improving recharge rate and quality of water by segregating it from liquid/ solid waste. Evaluation in terms of share of used water (for construction) compensated per year.
RA-2	Roof top rain water harvesting	W3-1	Identifying and designing roof top rain water harvesting on toll plazas and way side amenities. Evaluation in terms of share of used water (for construction) compensated per year.
6.	**CSR activity**	**W2**	
CSR-1	Corporate social responsibility to promote healthy/hygienic practices	W2-1	Solid and liquid waste management of dhabas or infrastructure development of government health/educational institutions along the road etc. Evaluation can be on the basis of coverage.
7.	**Custom Criteria**		Any other project specific criteria.

Table 4 Approach and Available Guidelines for Quantification of Evaluating Criterias

S. No	Criteria and Sub-criteria	Approach	Statute/Guidelines, if any*
1.	**Sustainable Design (SD)**		
SD-1	Alignment design	• % length covered with any innovative approach out of total project road. • % of road length following the existing alignment (excluding bypass/realignments). • % share of number or length provided out of those demanded during public consultation.	Not applicable
SD-2	Traffic flow improvement	• % increase in journey speed • % improvement in V/C ratio	Refer Traffic analysis conducted for the project road and related IRC codes (IRC:64 "Guidelines for Capacity of Roads in Rural Areas)".
SD-3	Traffic safety	% reduction in accidents as estimated for the project.	IRC:SP:88 "Road Safety Audit Manual ".

S. No	Criteria and Sub-criteria	Approach	Statute/Guidelines, if any*
SD-4	Long life pavement design	% share of no. of years increased.	Not applicable
SD-5	Habitat Fragmentation	% share of provision made out of total required along settlements or wildlife areas to ensure uninterrupted and safe crossing of human, cattle and wild animals.	Eco friendly measures to mitigate impact of linear Infrastructure on wildlife; IRC:103 "Guidelines for Pedestrian Facilities" or any other related Guidelines.
SD-6	Cut and fill	% share of cut material to be reused.	Not applicable
Materials & Resources (MR)			
MR-1	Recycled content	% of recycled content out of total materials required for the project.	**IRC:SP:58** "Guidelines for Use of Fly Ash in Road Embankments". **IRC:SP:98** "Guidelines for the Use of Waste Plastics in Hot Bituminous Mixes (Dry Process) in Wearing Course". **IRC:120** "Recommended Practice for Recycling of Bituminous Pavements". Fly Ash Notification, 1999, Amendment, 2016 and other relevant IRC Codes
MR-2	Carbon footprint	% reduction compared to alternate pavement type considering material type, quantity, source distance, modes of transportation, use of type and quantity of fuel or energy sources etc. This shall include both embodied and direct carbon dioxide equivalent emission factors as would be applicable.	Carbon footprint of different pavement types used in India can be calculated using calculators like CHANGER on the basis of material type, quantity, fuel usage, source distance etc.
Storm Water Management (SM)			
SM-1	Provision for management practice	% share of length covered with drainage facility; % share of length where better provisions like ISWM have been made.	Virginia Storm Water Management Handbook, 2010; City Indianapolis- Storm Water Design and Specification Manual.

S. No	Criteria and Sub-criteria	Approach	Statute/Guidelines, if any*
			Other relevant established Guidelines.
SM-2	Maintenance	Rank shall be given in reverse order i.e. for amount (in terms of %) of relief in requirement of maintenance.	-do-
SM-3	Run off treatment	% share of pollutants that can be removed. Can be referred from authentic literature or manual.	-do-
SM-4	Ground water recharge	% share to be recharged out of total water tapped in project area (annual rainfall x area- evapotranspiration). *Some useful formulae-* *Total annual RWH potential (cubic metre) = {[Rainfall (m) x Area of catchment (square metre) x Runoff coefficient x filter efficiency] –W}* *Rate of Evaporation (W)= ((Pw-Pa)* (0.089+0.0782*V)/Y)* 3600*[1] Volume of tank = days of dry season × No. of people × lpcd) + Et	1. Manual on Norms and Standards for Environment Clearance of large construction projects, MoEFCC. 2. AHSRAE Fundamentals Handbook, 2001 3. Manual on Artificial Recharge of Ground Water, 2007 by CGWB 4. MoRTH Circular No. RW/NH-33044/14/2003-S&R(R)dated September 5, 2013 "Tentative Guidelines for Drainage through Rain Water Harvesting and Artificial Recharge along".
SM-5	Permeable area	% share of unpaved area	Not applicable

[1] *Where, W = Rate of evaporation at the surface of the water level (kg/h/m²)*

Pw = Vapour pressure at saturation taken at the temperature of surface of water, in kPa

Pa = Vapour pressure at the dew point according to the temperature of the ambient air of the room, in kPa

V = Air velocity above at the surface of water, in m/s

Y = Latent heat necessary according to the change of state of the water vapour at the temperature of surface of water, in kJ/kg

S. No	Criteria and Sub-criteria	Approach	Statute/Guidelines, if any*
Energy and Environment (EE)			
EE-1	Cool pavement	Typical Albedo- 0.04 to 0.16 for asphalt pavements; 0.18 to 0.35 for concrete pavements. Cool Pavement (%)= [(LSA+PSA)/A]X100% LSA is total light colored area with albedo 0.3; PSA- total permeable area; A is the total paved surface.	Green Roads Manual™, 2011; FHWA Guidelines.
EE-2	Lighting efficiency	% share of usage of renewable energy source for street lights, cooling and lighting in toll plazas and way side amenities.	Relevant Guidelines of Ministry of New and Renewable Energy may be referred to.
EE-3	Noise Attenuation	% of noise level attenuated against limit; % of sensitive locations treated out of total identified. Some useful formulae- Path length difference (δ) = $R_1 + R_2 - R_0$ [II] Width of road: ht of barrier = 10:1 $L_2 = L_1 + 10 * Log\ 10\ (d_1/d_2)$ [III] $L_{A+B} = 10 \times \log_{10} [\log_{10}^{-1} (L_A/10) + \log_{10}^{-1} (L_B/10)]$	FHWA Highway Noise Barrier Design Handbook, 2001; MoRTH, Guidelines for Expressways, Part-1, Vol-11- Design

[II] ***Path length difference (δ) = $R_1 + R_2 - R_0$***

Where, R_1 is the distance (m) from source height to top edge of the barrier

R_2 is the distance receptor height to top edge of the barrier

R_0 is the distance between the source and receptor

[III] ***$L_2 = L_1 + 10 * Log\ 10\ (d_1/d_2)$***

Where, L_2 is the sound level at distance d_2

L_1 is the predicted sound level at distance d_1

d_1 is 1m from paved road edge

d_2 is distance of the boundary wall from road edge

S. No	Criteria and Sub-criteria	Approach	Statute/Guidelines, if any*
EE-4	Carbon sequestration & reduction	% of CO_2 that can be sequestered against that emitted during operation. $CAB = V \times D \times BEF \times CF$[IV] SOC = ρ × d × percentage of C[V] TEEMP software for Vehicular CO_2 emission during operation. Emission factors of ARAI can be used.	GHD reference documents.
EE-5	Vehicular emission of ambient air pollutant	% reduction in Nox and PM can be calculated using TEEMP software and emission factors given by ARAI; % improvement in International Roughness Index.	Relevant Guidelines as would be available.
EE-6	Site Vegetation or Plantation Plan	% of total project area under vegetation or in comparison to existing vegetation cover.	IRC:SP:21 "Guidelines on Landscaping and Tree Plantation" Green Highways (Plantation, Transplantation, Beautification and Maintenance) Policy, 2015 MoRTH Circular No. RW/NH-33044/1/2014-S&R(R) "Guidelines on Transplantation of Trees for Widening of National Highways"

[IV] ***CAB = V × D × BEF × CF*** Where, CAB = Carbon stock in above-ground biomass of given tree species Units: tC; V = Merchantable volume of given tree species Units: cubic m; D = Basic wood density of given species. Units: td.m. cubic m; BEF = Biomass Expansion Factor; CF = Carbon fraction of dry matter for given species. Units: t C/t d.m. The Below Ground Tree Biomass (BGTB) is calculated by multiplying the AGTB with a default value of 0.27, provided by IPCC (IPCC, 2006). Carbon stock from the BGTB is calculated by multiplying the total BGTB with a default value of 0.45.

[V] ***SOC = ρ × d × percentage of C*** Where, SOC = SOC stock per unit area (tonnes/ha), ρ = soil bulk density (g/cm^3), d = depth at which the sample was taken (cm), and C = carbon concentration (percentage).

S. No	Criteria and Sub-criteria	Approach	Statute/Guidelines, if any*
EE-7	Solid and liquid waste management	% Share of solid and liquid waste treatment both during construction (in camps) and operation (in way side amenities and toll plazas) against that estimated to be generated using bio-toilets, packaged sewage treatment plant, organic waste convertors, recycling of inorganic waste, oil interceptors etc.	Solid Waste Management Rules, 2016. Construction and Demolition Waste Management Rules, 2016.
EE-8	Environment, Health and safety	• % share of toilets proposed or provided against required. • % share of safe drinking water proposed or provided against required @ 45 lpcd to the labours etc. • % share of personnel protective equipment against no. of labours those who are supposed to be using them. • % share of labors actually using (or perused to use) safety equipment based on their nature of work (this can be calculated only during construction/ maintenance stage). • A fully functional dispensary for first aid treatment along with registered doctor and presence of ambulance for easy access to nearby hospital.	Circular Memo No: SAC/ CT & PT/2015 dated 13-08-2015 of Swachha Andhra Corporation, MA&UD Department or any other Guidelines for community toilets under Swachh Bharat Abhiyan. It is mentioned that one seat per 25 female and one seat per 35 males shall be constructed for community toilets. Other provisions of sanitation on community toilets can be referred as a Standard while calculating the provisions of hygiene. World Bank's General EHS Guidelines (www.ifc.org/ ehsguidelines) may be followed for identifying any other parameters.

S. No	Criteria and Sub-criteria	Approach	Statute/Guidelines, if any*
		• Risks of occupational hazard shall be classified as per World Bank Guidelines and % share can be assigned as follows: 'Low risk' = Minus 20% 'Moderate Risk'= Minus 50% 'High risk' =Minus 80% 'Extreme risk'= Minus 100%	
Interventions as Reparation Activities or Enhancement (RA)			
RA-1	Rain water harvesting through ponds	% of water proposed to be compensated or compensated against that proposed to be used or used for construction per year.	Refer Guidelines of SM.
RA-2	Roof top rain water harvesting		
CSR Activities			
CSR-1	Corporate social responsibility to promote healthy/hygienic practices	• % of numbers or area or quantity covered for treatment and management out of total Solid and liquid waste generated by dhabas. • % of number of Government health/ educational institutions taken up along the road for infrastructure development out of total requirement.	Refer Guidelines as given in EE-8.

*Apart from those mentioned here, any amendments to existing statutes/new circular/Guidelines of Competent Authorities (viz. MoEFCC, MoRTH, IRC) shall be applicable.

Table 5 Standard Ranks against Percentage Share of Various Interventions

Percentage share	Ranks
0-15	1
15- 30	2
30- 45	3
45- 60	4
60-75	5
75- 90	6
>90	7

Table 6 Ranks Assigned to the Total Percentage of Weighted Ranks

Certified	If 50% of total ranks achieved
Silver	If 51% to 70 % of total ranks achieved
Gold	If 71% to 80% of total ranks achieved
Evergreen	If 81% and above of total ranks achieved

4. APPLICABILITY OF STAGES

These Guidelines have included the applicability of various criteria and sub-criteria in different stages of a roads life cycle i.e. Design or DPR stage, construction (including pre-construction) stage and operation cum maintenance stage. Refer **Table 7**.

During the design stage proposed designs and greener road provisions along with their maintenance or monitoring schedules shall be evaluated. At pre- construction and construction stage, execution of the proposed provisions shall be evaluated and at operations and maintenance stage, functionality and maintenance of the provisions shall be evaluated.

Table 7 Applicability of Criteria at Different Stages of a Roads Life Cycle

S. No	Criteria and Sub- criteria	Design Stage	Pre-Construction & Construction stage	Operation & maintenance stage
1.	**Sustainable Design (SD)**			
SD-1	Alignment design	Yes		
SD-2	Traffic flow improvement	Yes		Yes
SD-3	Traffic safety	Yes	Yes	Yes

S. No	Criteria and Sub- criteria	Design Stage	Pre-Construction & Construction stage	Operation & maintenance stage
SD-4	Long life pavement design	Yes	Yes	Yes
SD-5	Habitat fragmentation	Yes	Yes	
SD-6	Cut & Fill	Yes	Yes	
2.	**Materials & Resources(MR)**			
MR-1	Recycled content	Yes	Yes	Yes
MR-2	Carbon footprint	Yes	Yes	Yes
3.	**Storm Water Management (SM)**			
SM-1	Provision for management practice	Yes	Yes	Yes
SM-2	Maintenance	Yes	Yes	Yes
SM-3	Run off treatment	Yes	Yes	Yes
SM-4	Ground water recharge	Yes	Yes	Yes
SM-5	Permeable area	Yes	Yes	Yes
4.	**Energy and Environment (EE)**			
EE-1	Cool pavement	Yes	Yes	Yes
EE-2	Lighting efficiency	Yes	Yes	Yes
EE-3	Noise Attenuation	Yes	Yes	Yes
EE-4	Carbon sequestration	Yes	Yes	Yes
	Reduction in carbon emission	Yes	Yes	Yes
EE-5	Vehicular emission of ambient air pollutant	Yes	Yes	Yes

S. No	Criteria and Sub- criteria	Design Stage	Pre-Construction & Construction stage	Operation & maintenance stage
EE-6	Site Vegetation or Plantation Plan	Yes	Yes	Yes
EE-7	Solid and Liquid Waste Management	Yes	Yes	Yes
EE-8	Environment, Health and Safety	Yes	Yes	
5.	**Interventions as Reparation Activities (RA)**			
RA-1	Rain water harvesting through ponds	Yes	Yes	
RA-2	Roof top rain water harvesting	Yes	Yes	Yes
6.	**CSR activity**			
CSR-1	Corporate social responsibility to promote healthy/hygienic practices	Yes	Yes	

5. MONITORING

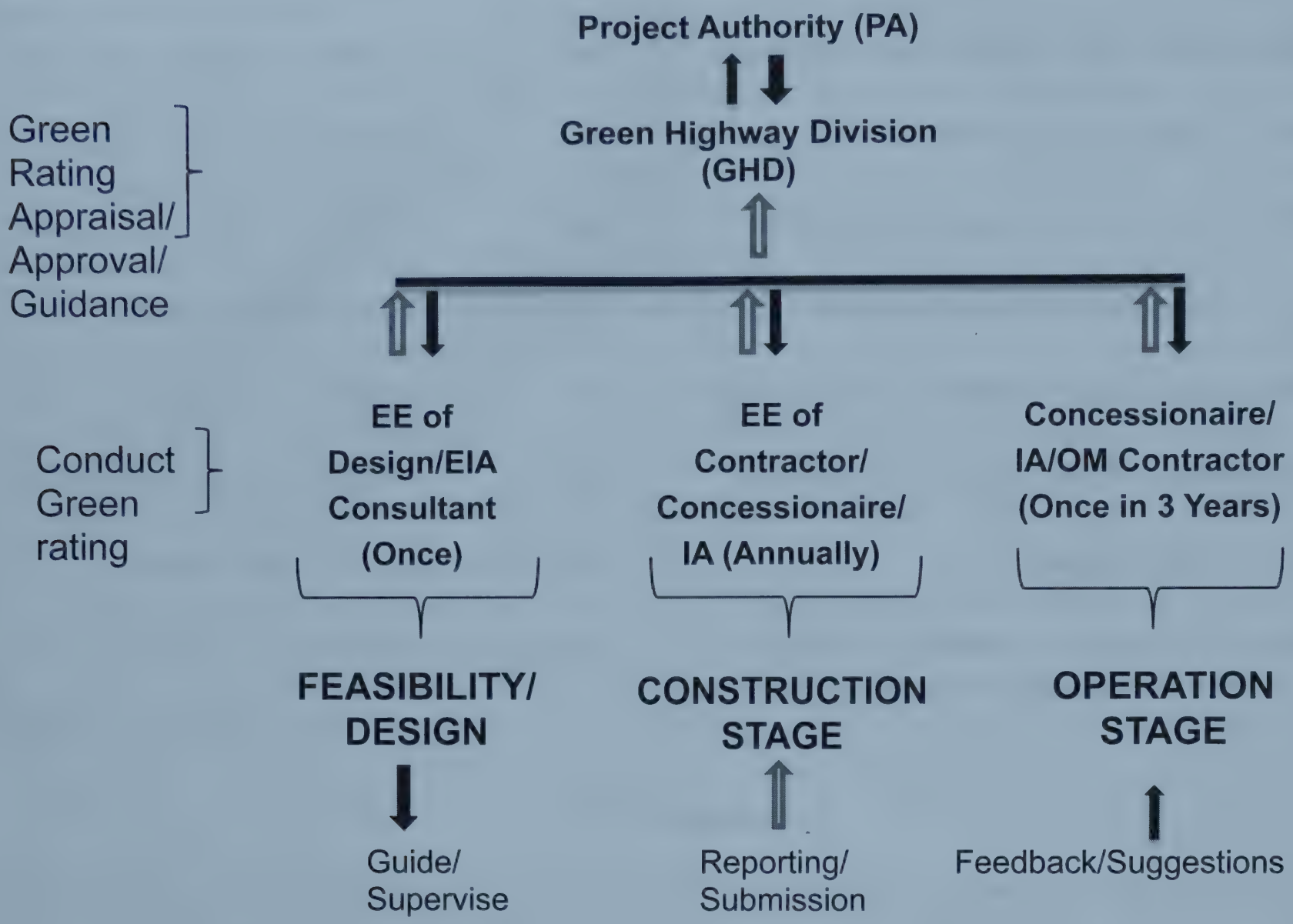
While performing the green rating exercise during design period, it would be necessary to perform all the quantitative assessments for each criterion and put them in a separate chapter on 'Green Rating' in the EIA report. In the design stage, green rating of the alternative scenario shall be done along with feasibility study and the preferred alternative shall be revised as per its detailed design. Provisions having spatial attributes like storm water management, rain water harvesting, pavement configuration etc. shall be supported with relevant drawings (cross-section, top plan etc.). Basis of numerical values obtained and equations used shall be mentioned clearly in the chapter. Authentic literature/documents can be referred with citation.

Periodic monitoring shall be done during construction and operation period by the road authority through their/concessionaire/Independent Authority or in house mechanism to ensure that the targets are met. The assessed values during design period can be termed as targets for that particular project. For example 8.43 lakh MT out of 34.55 lakh MT construction material is recycled material i.e. 24.39%. This value can be termed as target value and ensured that the target is met during construction. In case of deviation, justification shall be provided. In case the assessed values during design stage are not met during construction or operation stage, green rating will have to be revised accordingly and as a result may lose on its weighted rank achieved during design stage.

The green rating worked out during design period and monitored during construction and operation will be reviewed by the Green Highway Division (GHD) of the Road Authorities.

6. PROPOSED INSTITUTIONAL ARRANGEMENTS

Fig. 2 illustrates a proposed Institutional structure that the road authorities may consider for adoption.



IA- Independent Authority; EE- Environment Expert;

Fig. 2 Institutional Arrangement

7. GREEN INCENTIVES

To inspire consultants and contractors to follow the green rating system and endeavor to implement it successfully, performing green rating for projects can be included as one of the eligibility criteria in contract documents as per decision of project authority. A time period shall be provided to consultants and contractors to carryout projects as per these Guidelines and get them rated.

A project rated certified, silver, gold or evergreen shall be taken up for green financing by floating green bonds in the market. As per SEBI's "Disclosure Requirements for Issuance and Listing of Green Debt Securities" dated 30th May, 2017, a project needs to be evaluated/reviewed/certified and these guidelines can be used for such evaluations. In case of green bonds, it needs to be assured that the finance has been invested on sustainable/environment friendly/low carbon

activities or projects. To ensure the same in case of roads, the quantified evaluation criteria of a green rated project can be used as the target to be achieved during implementation. Currently, such a system is not in practice and shall be explored by road project authorities in collaboration with SEBI to establish the mechanism.

ANNEXURE I

CHECKLIST

DELPHI WEIGHTAGE SYSTEM- EXPERT OPINION FOR DECIDING WEIGHTAGE OF EVALUATION CRITERIA FOR GREEN RATING OF HIGHWAYS(ROUND 1/2/3)

Name:	
Designation, Organization:	
Contact Number:	
Email Id:	
Signature & Date	

Please put a tick mark to choose the weightage of the following criteria and sub-criteria. Weightage would increase from 1 to n.

Table I- Evaluation Criteria		**Weightage (increases from 1 to 6)**					
S. No	**Evaluation Criteria**	**1**	**2**	**3**	**4**	**5**	**6**
1.	Sustainable Design (SD)						
2.	Materials & Resources (MR)						
3.	Stormwater Management (SM)						
4.	Energy and Environment (EE)						
5.	Interventions as Reparation Activities and Enhancement (compensating for water used during construction through RWH) (RA)						
6.	CSR activity						

Table II.1 –Sustainable Design (SD)		**Weightage (increases from 1 to 6)**					
S. No	**Evaluation Sub-Criteria**	**1**	**2**	**3**	**4**	**5**	**6**
1.	Alignment Design						
2.	Traffic Flow Improvement						
3.	Traffic Safety						
4.	Long Life Pavement Design						
5.	Habitat Fragmentation						
6.	Cut & Fill						

Table II.2 - Materials & Resources (MR)		Weightage (increases from 1 to 2)						
S. No	**Evaluation Sub- Criteria**	**1**	**2**					
1.	Recycled content							
2.	Carbon footprint							

Table II.3 - Stormwater Management (SM)		Weightage (increases from 1 to 5)				
S. No	**Evaluation Sub-Criteria**	**1**	**2**	**3**	**4**	**5**
1.	Provision for Management Practice (anything innovative or better)					
2.	Maintenance (Intensity and Frequency)					
3.	Run off Treatment					
4.	Ground Water Recharge					
5.	Permeable Area					

Table II.4 - Energy and Environment (EE)		Weightage (increases from 1 to 8)							
Sl. No	**Evaluation Sub- Criteria**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1.	Cool Pavement								
2.	Lighting Efficiency								
3.	Noise Attenuation								
4.	Carbon sequestration/reduction in emission								
5.	Vehicular emission of ambient air pollutant								
6.	Site Vegetation or plantation Plan								
7.	Solid and liquid waste management								
8.	Environment, Health and Safety								

Table II.5- Interventions as Reparation Activities and Enhancement (compensating for water used during construction through RWH) (RA)		Weightage (increases from 1 to 2)						
Sl. No	**Evaluation Sub-Criteria**	**1**	**2**					
1.	Rain water harvesting through ponds							
2.	Roof top rain water harvesting							

ANNEXURE II

CASE STUDY
GREEN RATING OF NATIONAL HIGHWAYS-1 FROM DELHI TO PANIPAT

An example of how these Guidelines should be applied to any particular project is given below. The section from Delhi to Panipat of NH-1 has been taken up for the case study. Length of this section is around 56 km with an RoW of 60m and configuration of 6 lanes and proposed to be developed as a safer–greener highway. It may be noted that this example has been cited for reference only and exact procedure, criteria as explained in the main document shall be followed.

Step -1 Criteria to qualify for being assessed as a "Green" highway

Qualifying criteria as per list given in **Table I** below are checked one by one and found incorporated in the Environment report and design report.

Table I Qualification of Project for Green Rating

S. No	Qualifying Criteria	Incorporated in Environment or Design report	Reference to the section of Environment or Design report
1.	Extensive study with baseline of all environmental parameters and Strength, Weakness, Opportunity Threat (SWOT) analysis of identified issues.	Yes	Section X.XX of Chapter X of EIA report.
2.	Storm Water Management Measures	Yes	Section X.XX of Chapter X of EIA report.
3.	Noise attenuation measures	Yes	Section X.XX of Chapter X of EIA report.
4.	Liquid and Solid Waste Management measures (solid waste includes all types of waste likely to be generated)	Yes	Section X.XX of Chapter X of EIA report.
5.	Air Pollution Mitigation Measures	Yes	Section X.XX of Chapter X of EIA report.
6.	Life Cycle Cost Analysis	Yes	Section X.XX of Chapter X of Design report.
7.	Greenhouse Gas Emission Assessment for Construction, Maintenance and Operation period	Yes	Section X.XX of Chapter X of EIA report.
8.	Life Cycle Inventory of Pavement Material	Yes	Section X.XX of Chapter X of EIA report.
9.	Stakeholders Consultation Plan	Yes	Section X.XX of Chapter X of EIA report.
10.	Formal Contractor Quality Control Plan	Yes	Section X.XX of Chapter X of Design report.

S. No	Qualifying Criteria	Incorporated in Environment or Design report	Reference to the section of Environment or Design report
11.	Environment Monitoring Plan for pre-construction, construction and operation stage	Yes	Section X.XX of Chapter X of EIA report.
12.	Plantation Plan	Yes	Section X.XX of Chapter X of EIA report.
13.	Environmental Management Plan for pre-construction, construction and operation stage	Yes	Section X.XX of Chapter X of EIA report.

Step-2 Listing the criteria/parameter

Criteria to be followed for this project have been modified to fit to the definition of the project i.e. improvement of an existing good condition road to make it safer and greener through an integrated approach (**Table II**). The criteria have been described in this table to help identify the project specific context in which improvement or modification has been measured. Weightages and sub-weightages are mentioned as per standard given in **Table II**.

Table II Criteria for green rating of NH-1 section from Kundli Chowk to Panipat

S. No	Criteria and Sub-criteria	Weightage	Description
1.	**Sustainable Design (SD)**	**0.18**	
SD-1	Alignment Design	0.050	The design of road alignment is already existing; any innovative measure taken to curb the main identified issue of road users.
SD-2	Traffic Flow Improvement	0.020	Reduction in congestion or average speed expected after improvement.
SD-3	Traffic Safety	0.030	Reduction in human-vehicle conflict; vehicle-vehicle conflict; cattle vehicle conflict.
SD-4	Long Life Pavement Design	0.070	Life cycle (years); frequency of mandatory maintenance.
SD-5	Public Input	0.010	In corporation of users' and local stakeholder's views and requirement into the design (no. of interventions recommended out of the requirements expressed by users).
2.	**Materials & Resources MR** (Specific to construction period)	**0.22**	
MR-1	Construction Waste Management	0.01	Use of construction and demolition debris.
MR-2	Reuse of pavement	0.04	Use of scarified bitumen in construction as sub-base.

MR-3	Recycled Content	0.03	Use of recycled material/reduction in waste dumps.
MR-4	Carbon footprint	0.07	Reduction in carbon emission during construction (both embodied emission of materials and direct emission due to fossil fuel burning).
MR-5	Ambient air pollution	0.05	Reduction in NO_x and SO_x
MR-6	Regionally provided material	0.02	Identification of material sources at minimum distance from project area
3.	**Storm Water Management (SM)**	**0.14**	
SM-1	Provision for Management Practice	0.050	Type of technology used and extent covered.
SM-2	Maintenance	0.005	In terms of maintenance requirement and estimated life of the structure in comparison with a traditional storm water drain.
SM-3	Run off treatment	0.010	Amount of run off to be treated and pollutants that could be removed.
SM-4	Ground Water Recharge	0.020	Amount of water that could be recharged.
SM-5	Permeable Area	0.015	Share of permeable area to that of non-permeable.
SM-6	Integrated Storm Water Management	0.04	Integration with landscaping and ground water recharge and pre-separation from sewage.
4.	**Energy and Environment (EE)**	**0.2**	
EE-1	Cool Pavement	0.025	Pavement with higher albedo.
EE-2	Lighting Efficiency	0.01	Use of renewable energy sources with low electricity consuming fixtures.
EE-3	Quiet Pavement	0.015	Reduction in noise level.
EE-4	Carbon Sequestration/ Reduction in Emission	0.060	Carbon footprint reduction during operation.
EE-5	Vehicular Emission of Ambient Air Pollutant	0.035	Improvement in ambient air quality during operation.
EE-6	Aesthetics	0.005	Material used for rectification/curtaining/ enhancing of eye soars identified.
EE-7	Site Vegetation	0.050	Share of vegetation cover within the project area.

5.	**Interventions as Reparation Activities (RA)**	**0.10**	
RA-1	Rain water harvesting through Ponds	0.06	Enhancement of ponds through improving recharge rate and quality of water by segregating it from liquid/solid waste. Evaluated in terms of share of used water (for construction) compensated per year.
RA-2	Roof top rain water harvesting	0.04	Identifying and designing roof top rain water harvesting on buildings. Evaluated in terms of share of used water (for construction) compensated per year.
6.	**CSR activity**	**0.09**	
CSR-1	Corporate social responsibility to promote healthy/hygienic practices	0.09	Solid and liquid waste management of Dhabas. Evaluated on the basis of coverage.
7.	**Project Identification (PI)**	**0.07**	Identification is only 10% of the work done.
PI-1	Solid Waste Management of Villages/Towns	0.02	Planning for reducing the nuisance along the road. Evaluated on the basis of coverage.
PI-2	Liquid Waste Management for Villages/Towns	0.01	Planning for reducing the nuisance along the road. Evaluated on the basis of coverage.
PI-3	Potential Green Belt Development	0.04	Vacant or barren area left with the 60m belt provided under Controlled area plan of National Capital Region Planning Board (NCRPB), apart from Agricultural land shall be developed as green belt. Evaluated on the basis of coverage.
	Total Weightage	**1.00**	

Step-3 Creation of scenarios

The existing condition of the road has been chosen as the base level for evaluating the performance of the proposed interventions. Three scenarios have been created. Scenario I and Scenario III are the important ones. Scenario II has been created in this case to comprehend the difference of greener highways (Scenario III) and conventional highways in a better way.

Scenario- I: Existing condition

The existing road is 6-lane with divided traditional or conventional bitumen pavement (TBP) carriageway with 1.5 m paved shoulder on either side. As rated by iRAP (International Road assessment Programme) the road is in a very good riding condition but very poor in terms of traffic safety. The present project scope is to improve the road in terms of safety and soundness to environment within the RoW (maximum possible extent). Details on each parameter are given in **Table III**.

Scenario- II: Improvement based on conventional practices

Being within the project scope and Improving the road with throughout service road of Portland cement concrete pavement (use of fly ash in earth work), improving the at grade u- turns, closing the unauthorized median openings and elevating the service roads for cross road movements. Following existing guidelines for avenue plantation and Storm Water Management. Details on each parameter are given in **Table III**.

Scenario- III: Improvement based on maximum feasible nature conforming techniques

Being within the project scope and using Portland cement with additives for structures (flyovers, drains, footpath, parking, VUP,PUP, bridge etc.), bio-retention technique for storm water management and integration of landscaping into it, use of renewable energy applications etc. Details are given in **Table III**.

Table III Details of criteria under different scenarios

S. No	Criteria and Sub-criteria	Description		
		Scenario -I	**Scenario- II**	**Scenario-III**
1.	**Sustainable Design (SD)**			
SD-1	Alignment Design	Unauthorized median opening; local traffic slowing through traffic to cross the road.	Elevated service roads with at grade U turns and closing unauthorized medians-(50% segregation).	Physical segregation of main carriageway from service road by railings; throughout service road; all grade separated junctions; closing of all median openings (100 % segregation).
SD-2	Traffic Flow Improvement	Journey speed 24 to 76kmph (average 50 kmph).	Journey speed 50 to 80 kmph or improvement by 40%.	Journey speed 60 to 80 kmph or improvement by 40%.
SD-3	Traffic Safety	346 Accidents/year	10% to 20% reduction in accidents expected.	30% to 50% reduction in accidents expected.
SD-4	Long Life Pavement Design	15 years with maintenance @ every 5 years.	30 years (50% more than of TBP).	30 years (50% more than of TBP).
SD-5	Public Input	Flyovers- 3 PUPs- 2	By default of design consideration without public consultation- a) Flyovers- 8 (would have been 100% as per demand) b) FOB- 15 (13%) c) VUP- 1 (10%) d) PUP- 2 (66%) e) Cycle track- Nil (0%)	a) Flyovers- 6 demanded & 9 provided (66% of what demanded by users). b) FOB- 2 demanded and 7 provided (28% demand). c) VUP- 10 demanded & 12 provided (90% of what demanded by users). d) PUP- 03 (100% of what demanded by users). e) Cycle track- 2m x13.05 km at Bahalgarh & Kundli. (100% of what demanded by users)

S. No	Criteria and Sub-criteria	Description		
		Scenario -I	**Scenario- II**	**Scenario-III**
			Cumulative- 37.8% proposed as per requirement of users	Cumulative 81.5% proposed as per requirement of users
2.	**Materials & Resources MR**			
MR-1	Construction Waste Management	Nil	100% use in rehabilitation of borrow areas.	100% use in rehabilitation of borrow areas.
MR-2	Reuse of Pavement	Nil	50% of scarified Granular Sub-base and Wet Macadam Mix.	50% of scarified Granular Sub-base and Wet Macadam Mix.
MR-3	Recycled content	0 out of 58.10 lakh MT	6.1 out of 56.62 lakh MT (10%).	8.43 lakh MT out of 34.55 lakh MT. i.e. 24.39%.
MR-4	Carbon footprint	Carbon foot print- 157.59 tCO_2 eq.	Carbon foot print- 111.85 tCO_2 eq. (Less by 29% than TBP)	Carbon foot print- less by 44% than TBP.
MR-5	Ambient air pollution	So_x- 27.8 lakh kg NO_x- 221.63 lakh kg	So_x- 19.79 lakh kg NO_x- 153.71 lakh kg (Less by 29.02% than TBP)	Less by 44% than TBP.
MR-6	Regionally provided material	81% material within 55km lead.	82% within 55 km lead.	73% material within 55 km lead.
3.	**Storm Water Management**			
SM-1	Provision for Management Practice	Storm water drain for 9 kms out of 113.4 km (both side) – 7.9 % coverage.	Storm water drain for 113.4 km – 100% coverage.	Bio retention for 34.7 km and drain for 22 km on the left; drain with ground water recharge trench on RHS for 56.7km- 100% coverage.

S. No	Criteria and Sub-criteria	Description		
		Scenario -I	**Scenario- II**	**Scenario-III**
SM-2	Expected Lifetime/ Maintenance	Lifetime- 25 years Maintenance - Nil	Lifetime: 25 years Maintenance: To be cleaned twice a year (Pre and post monsoon) in case of storm water drains (STD) without any recharging pits – 40% increase in maintenance activity. Rank shall be given in reverse order i.e. for 60% relief in requirement of maintenance.	Life time: 20 years Maintenance: Bio-retention and ground water recharge trench: a) After every storm exceeding ½ inch of rainfall for 1st six months. b) 4 times a month watering for initial 2 months of July – August depending on rainfall. c) Mulch raking twice during growing season. d) Replace mulch layer every 3 years. e) Prune trees and shrubs annually. f) Remove sediments in pre-treatment cell in 2-3 years (80% more than STD). Rank shall be given in reverse order i.e. for 20% relief in requirement of maintenance.
SM-3	Run off Treatment	Nil	No removal (0%)	a) Removal of oil/grease, debris, suspended particles – 95% b) Removal of hydrocarbons – 75% c) Metallic ions- 90% (86% removal against 0 through STD)
SM-4	Ground Water Recharge	Nil (except for natural infiltration from outlet- not quantified)	Nil (except for natural infiltration from outlet- not quantified)	14.05 lakh m^3 through bio-retention on left and recharge trench along the right drain (100% more than STD).

S. No	Criteria and Sub-criteria	Description		
		Scenario -I	**Scenario- II**	**Scenario-III**
SM-5	Permeable Area	7.41 Ha.- 2.21% of total area	34.96 Ha- 10.46% of total area	83.37Ha -24% of total area
SM-6	Integrated Storm Water Management	Separate area for landscaping and STD; Storm Water mixing with sewage.	Separate area for landscaping and STD however separated from sewage – 50% integration.	Integration of vegetation and Storm Water Management- 100% integration.
4.	**Energy and Environment**			
EE-1	Cool Pavement	0.05 albedo. Surface Temperature around 65° to 70°C (Green Roads Manual TM,2011)	0.3 -0.4 albedo.	0.05 albedo (0% more than TBP). Surface Temperature around 65° to 70°C (Green Roads Manual ™, 2011).
EE-2	Lighting Efficiency	Only 20 % present out of total required.	2499.52 kW/year of electricity requirement in case of grid connected incandescent bulb street lights- efficiency is 0%.	0 % of electricity required for solar-LED. Efficiency is by 100%.
EE-3	Noise attenuation	Nil	Nil	23 dB(A) shall be reduced by using noise barriers to reach day time limit of 50 DB(A) for residential areas (100%).
EE-4	Carbon sequestration reduction in emission	0.211% through landscaping.	1.08 % through landscaping.	22.97% through landscaping, smart Traffic Management, Solar–LED lighting and fuel saving.
EE-5	Vehicular emission reduction of ambient air pollutant	Nil	Nil	SO_x- 4065.39 kg/km/yr less against 0 kg/km/yr in TBP pavement. NO_x- 32148.9 kg/km/yr less against 0 kg/km/yr in TBP pavement.

S. No	Criteria and Sub-criteria	Description		
		Scenario -I	**Scenario- II**	**Scenario-III**
EE-6	Aesthetics	Nil	Nil	Use of vegetative screens at 3 locations. Enhancing the water bodies at 4 locations. (100% - treatment to all eye soars through methods for that would increase vegetation cover/quality of surface and ground water).
EE-7	Site Vegetation	Existing -7.3 ha.- 2.18% of total area.	As per IRC:SP:21 -34.85 ha. – 10.43% of total area.	60.69 ha – 18% of total area.
5.	**Interventions outside Project Area as reparation activities**			
ORA-1	Rain water harvesting through ponds	Nil	Nil	30% of the water used in construction compensated per year.
ORA-2	Roof top rain water harvesting	Nil	Nil	
6.	**CSR activity**			
CSR-1	Corporate social responsibility to promote healthy/hygienic practices	Nil	Nil	100%
7.	**Project Identification**			
PI-1	Solid Waste Management of Villages/Towns	Nil	Nil	Yes (Identification is assumed to be only 10% of a work done).
PI-2	Liquid Waste Management for Villages/Towns	Nil	Nil	Yes (Identification is assumed to be only 10% of a work done).
PI-3	Potential Green Belt Development	Nil	Nil	Yes (Identification is assumed to be only 10% of a work done).

Step - 4 Assigning Ranks

Improvements likely to be achieved under Scenario II and III has been estimated and expressed in percentage increment on the base data of Scenario I. Percentage from 0 to 100 has been assigned ranks from 0 to 7 as per Standards given in **Table IV**.

Step - 5 & 6 Computations of Weighted Ranks

Ranks assigned to different groups of percentage share are as given in **(Table IV)**. Total weighted ranks for each Scenario and maximum weighted rank for the project is calculated using formula 1 and 2 mentioned earlier **(Table V)**.

Table IV Ranks against Percentage Share of Various Interventions

Percentage share	Ranks
≤ 0	0
1-15	1
15- 30	2
30- 45	3
45- 60	4
60-75	5
75- 90	6
≥90	7

Step-7 Green Rating

Rating of the scenarios is done using formula 3 as mentioned in the guideline. Scenario II achieved 31% of maximum weighted ranks and Scenario III achieved 59% of maximum weighted ranks. Hence, the case project implemented with Scenario II conditions will help it achieve “certified” category and that with Scenario III will be in “Gold category”.

Table V. Ranks assigned to Different Parameters in Scenario II & III in comparison to Scenario –I

S. No	Criteria and Sub-criteria	Scenario- II				Scenario-III			
		Percentage of improvement achieved	Ranks	Weightages	Weighted ranks	Percentage of improvement achieved	Ranks	Weightages	Weighted ranks
1.	**Sustainable Design (SD)**								
SD-1	Alignment Design	50	4	0.050	0.2	100	7	0.050	0.35
SD-2	Traffic Flow Improvement	40	3	0.020	0.06	40	3	0.020	0.06
SD-3	Traffic Safety	20	2	0.030	0.06	50	4	0.030	0.12
SD-4	Long Life Pavement Design	50	4	0.070	0.28	50	4	0.070	0.28
SD-5	Public Input	38	3	0.010	0.03	82	6	0.010	0.06
	Sub total		**16**	**0.180**	**0.630**		**24**	**0.180**	**0.87**
2.	**Materials & Resources MR**								
MR-1	Construction Waste Management	100	7	0.01	0.07	100	7	0.01	0.07
MR-2	Reuse of Pavement	50	4	0.04	0.16	50	4	0.04	0.16
MR-3	Recycled Content	10	1	0.03	0.03	24	2	0.03	0.06
MR-4	Carbon Footprint	29	2	0.07	0.14	44	3	0.07	0.21
MR-5	Ambient Air Pollution	29	2	0.05	0.1	44	3	0.05	0.15
MR-6	Regionally Provided Material	82	6	0.02	0.12	73	6	0.02	0.12
	Sub total		**22**	**0.22**	**0.62**		**25**	**0.22**	**0.77**

S. No	Criteria and Sub-criteria	Scenario- II				Scenario-III			
		Percentage of improvement achieved	Ranks	Weightages	Weighted ranks	Percentage of improvement achieved	Ranks	Weightages	Weighted ranks
3.	**Storm Water Management**								
SM-1	Provision for Management Practice	100	7	0.05	0.35	100	7	0.05	0.35
SM-2	Expected Lifetime/ Maintenance	60	4	0.005	0.02	20	2	0.005	0.01
SM-3	Run off Treatment	0	0	0.01	0	86	6	0.01	0.06
SM-4	Ground Water Recharge	0	0	0.02	0	100	7	0.02	0.14
SM-5	Permeable Area	10	1	0.015	0.015	24	2	0.015	0.03
SM-6	Integrated Storm Water Management	50	4	0.04	0.16	100	7	0.04	0.28
	Sub Total		**16**	**0.14**	**0.545**		**31**	**0.14**	**0.87**
4.	**Energy and Environment**								
EE-1	Cool Pavement	87	6	0.025	0.15	0	0	0.025	0
EE-2	Lighting Efficiency	0	0	0.01	0	100	7	0.01	0.07
EE-3	Noise Attenuation	0	0	0.015	0	100	7	0.015	0.105
EE-4	Carbon sequestration/ reduction in emission	1.08	1	0.06	0.06	22.97	2	0.06	0.12
EE-5	Vehicular emission reduction of ambient air pollutant	0	0	0.035	0	4	1	0.035	0.035
EE-6	Aesthetics	0	0	0.005	0	100	7	0.005	0.035
EE-7	Site Vegetation	10.43	1	0.05	0.05	18	2	0.05	0.1
	Sub Total		**7**	**0.2**	**0.26**		**32**	**0.2**	**0.465**

S. No	Criteria and Sub-criteria	Scenario- II					Scenario-III			
		Percentage of improvement achieved	Ranks	Weightages	Weighted ranks		Percentage of improvement achieved	Ranks	Weightages	Weighted ranks
5.	**Interventions as reparation activities**									
RA-1	Rain water harvesting through ponds	0	0	0.06	0		30	2	0.06	0.12
RA-2	Roof top rain water harvesting	0	0	0.04	0		30	2	0.04	0.08
	Sub Total		**0**	**0.1**				**4**	**0.1**	**0.2**
6.	**CSR activity**									
CSR-1	Corporate Social Responsibility to promote healthy/ hygienic practices	0	0	0.09	0		100	7	0.09	0.63
7.	**Project Identification**									
PI-1	Solid Waste Management of Villages/Towns	0	0	0.02	0		10	1	0.02	0.02
PI-2	Liquid Waste Management for Villages/Towns	0	0	0.01	0		10	1	0.01	0.01
PI-3	Potential Green Belt Development	0	0	0.04	0		10	1	0.04	0.04
	Sub Total		**0**	**0.07**	**0**			**3**	**0.07**	**0.07**
	Total ranks achieved		**63**	**1**	**2.055**			**126**	**0.96**	**3.875**
	Maximum Weighted rank for the Project			**6.58**						

REFERENCES

1. Soderlund, m. (2007, Month 31). Green Roads: A Sustainability Ratings System for Roadways. Masters' Thesis . Seattle: University of Washington.
2. (2011). Green Roads TM Manual v 1.5 . University of Washington.
3. Shepherd, G. (2010). FHWA's Sustainable Highways Self Evaluation Tool. Retrieved from http://www.transportation.org/sites/aashto/docs/FHWA%20Sustainable%20Highways%20Tool%20-%20AASHTO%2010-29-10%20v2%20(2)final.pdf.
4. Lee, J. (2013). Building Environmentally and Economically Sustainable Transportation Infrastructure: Green Highway Rating System. Journal of Construction Engineering and Management . Retrieved August 19, 2017, from https://www.researchgate.net/publication/273616159.
5. Abdul, K. (2012). Applicability of a Road Rating System to the City of Vancouver, Streets and Electrical Design, City of Vancouver. Retrieved August 19, 2017, from https://sustain.ubc.ca/sites/sustain.ubc.ca/files/Lighter%20Footprint%20%28green%20operations%29%20-%20Kamal%20Abdul%20-%20Green%20Roads%20Rating%20System.pdf.
6. Bryce, J. (2008). Developing Sustainable Transportation Infrastructure- Exploring the Development and Implementation of a Green Highway Rating System. ASTM International Standards World Wide.
7. Bhattacharya, Tamosi; Shukla, Anuradha;. (2017). Procedure for Green Highways Rating System in India (GHRSI). Journal of the Indian Roads Congress , Volume 78-1, 45-56.
8. RAND (n.d.). Retrieved September 28, 2018, from www.rand.org; https://www.rand.org/topics/delphi-method.html).
9. Dalkey, N. C. (1967, October). Retrieved September 28, 2018, from www.rand.org: https://www.rand.org/topics/delphi-method.html.

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